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## VISUAL HALLUCINATIONS ACCOMPANYING ORGANIC LESIONS OF THE BRAIN, WITH SPECIAL REFERENCE TO THEIR VALUE AS LOCALIZING PHENOMENA\*

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### INTRODUCTION

The localization of organic lesions of the brain is attended by many difficulties, and is always accompanied by a considerable degree of uncertainty. A tumor in one part of the brain may give rise to symptoms that are rare for growths in that location, but are common to lesions in a part remote from the involved area. Any sign, therefore, that can be used as an aid in cerebral localization is of importance.

Visual hallucinations are not uncommon in lesions of the brain, but in the literature confusion exists as to their interpretation and their value as localizing phenomena. Hallucinations of smell and the various types of aphasia point rather definitely to irritation of certain given convolutions or centers of the brain, but it is possible that hallucinations of vision may follow upon irritation of any of the visual structures and may or may not indicate an invasion of the visual centers.

Visual disturbances, playing so prominent a part in the

\* Candidate's thesis for membership accepted by the Committee on Theses.

symptomatology of lesions of the brain, come within the province of the ophthalmologist for their interpretation. However, the subject of visual hallucinations has engaged the attention of the neurologists more than it has that of the ophthalmologists. Reports of cases of visual hallucinations with discussions of the subject are found almost exclusively in neurologic publications.

The object of this paper is to give a thorough review of the literature upon the subject of visual hallucinations complicating organic lesions of the brain; to report some of the cases that have come under the personal observation of the author; to consider the character of the hallucinations and the location of the lesion in reference to the area of the visual pathway involved; to discuss the theory of their production; and to estimate the value of visual hallucinations as localizing phenomena. The scope of the article is limited to a consideration of hallucinations of vision occurring in cases of organic lesions of the brain in the sane.

#### DEFINITION OF HALLUCINATION

Dorland defines a hallucination as "A sense-perception not founded on an objective reality." The Standard Dictionary's definition is: "An hallucination is a sensation originating in the mind without external stimulus." Esquirol<sup>48</sup> states: "A person is said to labor under hallucination, or to be a visionary, who has a thorough conviction of the perception of a sensation, when no external object suited to excite this sensation has impressed the senses. . . . Hallucinations are therefore neither false sensations, nor illusions of the senses; neither erroneous perceptions, nor errors resulting from organic sensibility."

#### ETIOLOGY OF HALLUCINATION

Hallucinations may be caused by intoxications of various sorts, such as occur in febrile diseases or after the ingestion

of certain drugs and chemicals, and by irritation of the structures that enter into the formation of the visual pathways, due to neoplasms, abscesses, hemorrhages, scars, and foreign bodies. Hallucinations may be present in disorders of nutrition; in neuroses, such as hysteria, chorea; and in the various psychoses.

#### CASES OF VISUAL HALLUCINATIONS REPORTED IN LITERATURE

The history of visual hallucinations is probably as old as the history of the human race. These phenomena have influenced the arts, literature, history, and religion of peoples for ages. Esquirol,<sup>48</sup> discussing this subject, wrote: "The austere writings of every people, the history of magic and sorcery in every age, together with the annals of mental medicine, furnish numerous facts in relation to the subject of hallucinations."

The belief in fairies, elves, demons, dragons, and devils no doubt had its origin in lilliputian hallucinations produced by intoxications of one kind or another.

The visions of Joan of Arc were an influence that changed the history of France. They led her to offer her services to King Charles, and a belief in spiritual visitations was a deciding factor in causing him to accept her services, and was the inspiration that swept her armies to victory over the English.

The burning bush seen by Moses, the swallowing of the snakes by the staff of Aaron, and the angel obstructing the passage of Balaam's ass would be considered by religious skeptics to have been visual hallucinations.

Shakespeare uses specters to advantage in dramatizing some of his plays, conspicuous instances of which are the meeting between Brutus and Caesar's ghost at Philippi and the coming of "Great Birnham Wood to high Dunsinane hill" in Macbeth. One may wonder if Swift, in his travels

with Gulliver, had not experienced a toxic hallucinosis of some sort. Certainly the figures and their activities that he described were no more intriguing, fanciful, and pleasing than were the characters seen in the lilliputian hallucinations of patients described by Leroy<sup>90</sup> and other writers. Bernard Shaw, in his "The Life of Joan of Arc," and Anatole France, in "The Crime of Sylvestre Bonnard," have recourse to the theme of hallucinations to add interest to their writings. Lafcadio Hearn has translated numerous ancient Chinese stories based on visions and spectral illusions. In ancient and modern literature this theme is used frequently.

Up to the beginning of the nineteenth century it was a fixed belief in the minds of most men and women that visions, ghosts, and supernatural visitations were spiritual phenomena of fact. Such belief had been fostered by religious teaching, and in some respects is to this day a part of the faith of most religious bodies.

Prior to the present era persons afflicted with hallucinations were objects of public interest. If the spectral phenomena that were seen did not conform to the religious ideas of the community, the victims of the hallucinations were likely to suffer persecution at the hands of the authorities. Beaumont<sup>11</sup> cites the case of Alison Pearson, a woman of Scotland, who, in 1586, suffered from spectral impressions and paralysis as a result of a plethoric condition. During her illness she claimed to be frequently in communication with the queen of Elfland and her fairies, and saw visions. She was indicted for holding a communication with demons, as fairies were then considered to be, and was burned at the stake.

In the sixteenth century Reginald Scott<sup>137</sup> and in the seventeenth and early part of the eighteenth centuries Beaumont<sup>11</sup> wrote extensively upon the subject of spectral phenomena, and Nicholson's *Philosophical Journal*, pub-

lished in the latter half of the eighteenth century, contains numerous reports of cases of illusions. It was during this period that scientists became interested in finding a physical basis for visions, ghosts, and apparitions.

#### REVIEW OF THE MEDICAL LITERATURE ON VISUAL HALLUCINATIONS

On January 1, 1805, Dr. John Alderson,<sup>3</sup> at the meeting of the Literary and Philosophical Society at Hull, read a paper on Apparitions. He endeavored to prove that visions of ghosts and specters were secondary to natural causes and were not the result of spiritual visitations. "Let us take care," he said, "never to introduce the immediate agency of Providence, where natural operations can be found sufficient to account for the effects. Nor ought we hastily abandon our inquiries after such second causes merely because we have been told that they are mysteries."

Alderson's report included three cases of spectral illusions. In one case these came on after trauma to the side of the head. In another the illusions were accompanied by an unusual deafness, and in the third case the illusions followed upon an excruciating headache which was temporarily relieved by a "formation of matter under the scalp." There was no report of an autopsy in any of his cases. His paper was published in 1810.

In 1805 T. Bishopp<sup>15</sup> reported a case of optical illusions occurring in a girl, aged twenty-two years, who had hysteria. The illusions consisted of seeing objects in an inverted position—persons standing on their heads—the illusions being present during convulsive attacks which lasted about an hour. The patient recovered.

In 1813 John Ferriar<sup>52</sup> wrote an essay on the Theory of Apparitions, and in 1824 Samuel Hibbert<sup>68</sup> published his "Sketches of the Philosophy of Apparitions." Ferriar conceived that "The unaffected accounts of spectral visions

should engage the attention of the philosopher as well as the physician. Instead of regarding these stories with the horror of the vulgar, or the disdain of the skeptic, we should examine them accurately and should ascertain their exact relation to the state of the brain and of the external senses."

In 1828 Bostock<sup>16</sup> related a personal experience with visual hallucinations. While suffering from a fever he was seized with a severe pain in the right temple, and for a period of three days and nights was subject to spectral appearances. For one day he saw human figures. Later he saw human faces and figures on a small scale, like a succession of medallions. Bostock believed that vision was due to vibrations that stimulated the retina and was familiar with retinal after-images. His explanation of the hallucinations was based on after-images. In this connection he says: "In certain diseased states of the nervous system the retina is more than usually disposed to retain these impressions, so that, for a long time after the exciting cause has been removed, the spectrum will still remain visible." Some of the cases reported by the early writers on the subject, judging from the symptoms described as being present, were obviously not visual hallucinations, but ordinary cases of diplopia and retinal after-images.

Prior to 1836 no anatomic studies had been made of cases in which there were visual hallucinations, and writers upon the subject contented themselves with imperfect reports of cases that had come under their own observation and with discussions of previously reported cases, with their views as to whether they were the result of humors in the blood, of plethora, or of miasmatic intoxications. Hibbert<sup>68</sup> believed that hallucinations were due to miasmatic or gaseous intoxications. He based his belief upon the sensations and hallucinations experienced by Sir Humphry Davy during his experiments upon himself with laughing gas. One of these experiments is described as follows: He was enclosed in an

air-tight breathing box of a capacity of about nine and one-half cubic feet, in which he allowed himself to become habituated to the exciting effects of the gas, which was administered gradually. After having been in confinement for an hour and a quarter, during which time no less than 80 quarts of gas were thrown in, various hallucinations were experienced.

In 1836 James Craig,<sup>31</sup> Esquire, Surgeon, reported the first case of visual hallucinations, with the autopsy findings. The case was that of a man of superior mental endowments who, in the enjoyment of good health and in the full possession of his faculties, began, in the year 1819, the seventy-sixth year of his age, to have visitations of spectral figures. The visitations were occasional and were not periodic as to the hour or day. The man was a well-to-do, retired British official who was noted as a linguist. The specters presented, in general, human countenances and figures. They were dressed in various ancient and modern costumes. These visitations continued for a few years. One vision was very frequently repeated. It was that of an elderly female with a brilliant eye, an arch and playful expression, and appeared to be ready to address him. She was dressed in an old-fashioned Scottish tartan plaid drawn like a hood over the head and fastened beneath the chin. The figures were seen equally well with the eyes open or closed, in daylight or in darkness. They were almost always of an agreeable character, and varied in size and as to the distance they stood from him, at times approaching from afar until they almost touched him. He knew that the figures were visionary. In 1823 he developed aphasia and agraphia. In 1831 his vision began to fail and he had lost his memory for the names of persons and things. On August 21, 1832, while dining with friends, he suddenly lost the power of speech. He seemed to be disconcerted, but was not affected in any other way. The following day, upon attempting to write a

letter, he could make only scratches. In July, 1836, he contracted a cold, developed a fever, and died nine days later.

Autopsy revealed the presence of adhesions between the dura mater and the inner surface of the skull, considerable effusion between the convolutions and over the surface of the brain, with great vascularity of the whole structure. Except for a small tubercle the size of a split-pea near the surface, the right hemisphere was normal. In the posterior lobe of the left hemisphere there was a cavity exceeding two inches in length, running obliquely outside of the left lateral ventricle, which was lined with a yellowish membrane; the brain substance surrounding it was much softened. The cavity was close to, but did not communicate with, the ventricle, which was normal. The base of the brain bore marks of inflammatory reaction. The internal carotids were ossified. In the left middle lobe, a little behind and to the left of the pituitary gland, there was a small diseased area, not exceeding a quarter of an inch in extent, similar to that found in the posterior lobe. The cerebellum was normal. There was a small tubercle on the posterior part of the medulla oblongata.

For seventeen years this patient had had visual hallucinations, and for thirteen years he had suffered from aphasia and agraphia.

The cavity in the posterior lobe of the left hemisphere was probably due to necrosis following thrombosis of a cerebral artery. The hallucinations may be explained by an irritation of the higher visual centers by the necrotic mass in the occipital lobe. Later Henschen reported a series of cases similar to that just recorded.

In 1843 Paterson<sup>111</sup> reported five cases of spectral illusions. His descriptions are incomplete and none of the cases came to autopsy. In his discussion as to the causes of the hallucinations he recites the experiences of Sir Isaac Newton, of himself, and of others with after-images, which he confuses

with spectral illusions. The description of one of his cases would suggest that the patient suffered from alternating attacks of diplopia, and that the double images were believed by Paterson to be illusions.

The second report of a case of visual hallucinations that came to autopsy is one by Esquirol.<sup>48</sup> This is as follows: M. D., a doctor of medicine, tall, of strong constitution and sanguine temperament, in August, 1822, at the age of thirty-six years, developed paralysis of one eye and of one of the commissures of the lips, with transient delirium. Two years later, in September, 1824, after a violent contest which took place at a consultation, he was suddenly seized with delirium. When he returned to his home, the patient wanted to bleed his wife, his children, and the domestics, and extracted from himself several pounds of blood. He experienced hallucinations of hearing and of vision. He was conscious of his condition, and he reasoned logically. When he was forty years of age, in October, 1826, M. D. believed that he saw a patient insult and violate his wife. In a furious passion he threw himself upon the innocent object of his wrath and injured him most seriously. The hallucinations of M. D. were equally intense and coherent. Their character always remained the same, and he was constantly excited by illusions of sight and of hearing. The patient was continually in conversation with spectral persons whom he saw and heard. At the age of forty-nine years, in June, 1835, cerebral congestion occurred during the night. The following day the lips were found to deviate toward the left, and sensibility was obtuse. He became emaciated and affected with a diarrhea, but the hallucinations and delirium persisted. On March 15, 1836, at the age of fifty years, after several days of prostration and diarrhea, the patient became speechless and died.

At the autopsy, performed on March 17, 1836, an ossified growth was found adherent to that portion of the dura mater

which forms the fold of the great falx and a few lines from the apophysis of the crista galli. The tumor was conoidal in form, and one and one-half inches in circumference. There were points of adherence between the meninges and the cortical substance of the brain. When the adhesions were removed, the cortex beneath was found to be red and ulcerated. The optic nerves were grayish, flattened, atrophied, and presented the color and transparency of wet parchment. The atrophy extended to the optic thalami.

This was possibly a case of a calcified cranio-pharyngeal pouch tumor which pressed upon the chiasm, causing an atrophy of the optic nerves and tracts. Hallucinations are rare in cases of tumors in this area.

In 1846 T. Abell<sup>1</sup> reported his own experiences with visual illusions. In 1838, in the fifty-ninth year of his age, the vision in his right eye began to fail; at first objects presented a smoky appearance and black specks danced before the eye. Later, objects assumed a revolving motion and he saw beautifully papered walls, which did not exist. "Although there was no morbid appearance, the sight became so distorted as to cross the axis of vision," and by 1842 the distortion had progressed to total blindness in both eyes without pain or inflammation. During the fall of 1843, while sitting by the stove in the evening, he saw a woman with a child in her arms sitting beside him. At about the same time he saw a child standing by him, looking into his face, and, although he knew that the figure was an illusion, it was so natural that he inadvertently put out his hand. From that time until February, 1846, when he wrote a second paper on the subject, the illusions were frequent and were of a great variety of pictures, including multitudes of soldiers marching in splendid array, a city of frame buildings which workmen were actively engaged in completing, and many panoramas. As the patient was reporting his own case, obviously there was no autopsy report.

The symptoms described by Dr. Abell suggest the presence of a brain tumor. He evidently had a hemianopia which progressed to total blindness.

In 1860 Abercrombie<sup>2</sup> related the history of two cases of visual hallucinations. One patient, a woman with a fever, saw a party of ladies and gentlemen in her room to whom a servant was passing a tray. In addition, for several days, she saw brilliant castles and churches. The other case was that of a man who saw a woman wrapped in a mantle enter his room, her face being concealed by a large black bonnet. Abercrombie believed that the hallucinations were false impressions, similar to the after-images described by Darwin, who had been experimenting with retinal impressions.

In 1881 Westphal<sup>163</sup> reported the case of a workman, aged forty-two years, who was admitted to the hospital because of unilateral convulsions involving the left side. For about a year the patient had had frequent recurrences of the convulsive seizures, usually without loss of consciousness, but often with inability to speak. Toward the end of the year bilateral left hemianopia occurred, and the patient developed visual hallucinations consisting of wavy, red, green, or blue lines which passed before his eyes; these were not confined to the blind field. On one occasion he saw "a sword hanging over his head about to drop on him." The patient died, and at autopsy all the convolutions posterior to the ascending parietal convolution in the right hemisphere, including the parietal, temporal, and occipital convolutions, were soft, spongy, and dark red. The remainder of the brain was normal.

In 1882 Ingels<sup>75</sup> reported the case of a man who, since early childhood, had been subject to convulsive seizures. At the age of twenty years he began to have attacks in which he saw visions of sacred hosts floating before his eyes. These disappeared for a year and then the hallucinations reappeared, accompanied by insomnia and irritability. After

a few weeks he was normal again. For several years he had recurring attacks of a similar nature, and in one of these he died of asphyxia. At autopsy the dura was found to be adherent to the left frontoparietal suture. It was also attached in plaques to the cortical substance of the left superior and anterior frontal gyri and to the left second and third occipital convolutions. The cortex beneath these plaques was red, edematous, and necrotic.

Seguin,<sup>139</sup> in 1886, in his collection and report, with autopsy findings, of 45 cases of hemianopia of central origin, made a most valuable contribution to ophthalmology and neurology. In one of the cases reported the patient was subject to visual hallucinations. The case was that of a man, aged forty-six years, who had become pale, weak, and emaciated, and lately had suffered from insomnia and indigestion. Within a year he developed an intermittent fever, numbness of the entire left side, most marked in the hand and foot, and left-sided blindness. Tests revealed a typical left lateral hemianopia which did not include the points of fixation. Central vision remained good. During the later stage of his illness he had visual and auditory hallucinations. The patient died of a malignant endocarditis. The autopsy report follows: "Viewing the brain from above, the occipital extremity of the right hemisphere appears thinner than its homologue. This is found to be due to the destruction of the mesial surface of the right occipital lobe by a large focus of yellow softening, evidently an old patch. The lesion involves the basal part of the cuneus, the fourth and fifth temporal gyri (Ecker), and a part of the gyrus hippocampi. The destruction does not quite attain the tip of the occipital lobe."

Seguin "had not the shadow of a doubt" but that the destruction of the right cuneus and the fifth temporal gyrus was the cause of the left lateral hemianopia. The softening was produced by an embolism of the third branch of the posterior cerebral artery—the occipital artery of Duret.

In 1890 Seguin published a second paper on lateral hemianopia in which he included the report of a woman who had visual hallucinations in the dark hemianopic fields. At the age of thirty-four years, just after the birth of her third child, she had an attack during which she felt a snap or sudden pain in the left temple, which was followed by pain in the head and blindness on her right side. In the blind field she saw the "images of a chair, a chicken, etc." There was a right lateral hemianopia, the vertical division line passing slightly to the right of the fixation point. The fundi were normal. Epileptic seizures followed as a sequel, but there was no hemiplegia or aphasia. A diagnosis of embolism of the left occipital artery, with consequent softening of the cuneus and the adjacent nervous substance, was made, but there was no anatomic evidence to support the diagnosis. Seguin's cases are important in that they are the first contributions to the literature of visual hallucinations occurring in the blind field.

In 1887 Reinhard<sup>126</sup> reported three cases of visual hallucinations in which autopsy revealed softening in the occipital lobes.

In 1887 Bennett and Gould<sup>12</sup> published a report of two cases which had a bearing upon localization of the visual centers; both patients were subject to visual hallucinations. The first case was that of a man, aged thirty-six years, who, six years before, had received a violent blow on the right side of the head. Subsequent to the blow, on an average of about once a week, he had convulsive seizures in which he lost consciousness. After most of these attacks he was subject to a violent mania which rendered him dangerous to those about him. All the organs and functions of the body were otherwise normal. The fundi were normal. Over the right parietal bone in the scalp there was a transverse cicatrix which was movable. The bone beneath appeared to be normal, and there was no tenderness. Hard pressure

over the scar caused the sensation of a flash of light, followed by loss of consciousness for a few seconds.

The epileptic attacks were usually preceded by a flash of bright red light, followed by visual hallucinations of different objects. No detailed description of the character of the visual hallucinations is given. By making a large trephine opening over the angular gyrus the patient was relieved.

In the second case subjective visual hallucinations were observed, but no description of them is given. A tumor was removed from the Rolandic area. After the death of the patient the angular gyrus was found to have been involved.

In 1888 Hughlings Jackson<sup>78</sup> reported a case of epilepsy in which the patient had hallucinations of taste, smell, and vision. He was subject to "dreamy states" during which he saw large buildings of various kinds. At times they would seem to be structures that he had seen before. On one occasion he saw a certain almshouse and could actually see the clock. The houses always appeared to be of a natural color. He did not always lose consciousness during these attacks, but when he did, it was just after having seen the buildings. The optic discs were normal. There was no record of an examination of the visual fields or of an autopsy.

The following year Hughlings Jackson and Charles E. Beever,<sup>77</sup> in their paper on the interpretation of a particular type of epilepsy, made an important contribution to the localization of the sense of smell. This paper is of particular interest to ophthalmologists as it is the first report published of a case of visual hallucinations resulting from a lesion in the anterior tip of the temporal lobe.

The patient, a widow, aged fifty-three years, a cook by occupation, had peculiar attacks that were ushered in by a tremor of the hands and arms, and accompanied by a sensation as of a horrible odor, a feeling of suffocation, and the specter of a little black woman flitting about the kitchen, who was agreeable but never spoke. The patient saw the

same woman in every paroxysm; she knew that the figure was not a real person, but she believed that it was a vision, and was much worried about it. She had frequent attacks—at times as many as three in a day. There were no ocular paralyses, nystagmus, or hemianopia. The pupils and fundi were normal.

Upon examination of the brain at autopsy it was seen that the right temporosphenoidal lobe at its most anterior extremity, immediately in front of the uncinate convolution, was the seat of a tumor the size of a tangerine. The growth was localized in the hippocampal lobule, which Ferrier,<sup>176</sup> in his experiments upon monkeys, had found to be the center of the sense of smell. The hallucinations of smell were believed to be due to an irritation of the hippocampal lobule, which was not entirely destroyed. The growth had also pressed upward upon the right lenticular nucleus and the internal capsule of the same side, which was believed to account for a weakness of the left side of the face and the left side of the tongue that had been present when the patient was admitted to the hospital.

The uncinate seizures, consisting of a dreamy state of unconsciousness, unpleasant hallucinations of taste and smell, smacking and tasting movements of the lips, all of which were described by Jackson as occurring in this patient, have become the classic syndrome for tumors in the anterior part of the temporal lobe.

The visual hallucinations apparently did not attract Jackson's especial attention, and no explanation of their occurrence was offered, although prior to that time the lesions in the case of patients so afflicted were generally believed to be found only in the occipital lobe. In this case the tumor had evidently exerted pressure upon the optic radiations as they passed through the temporal lobe.

In 1889 de Schweinitz<sup>136</sup> collected five cases of migraine from the literature and added one case of his own, the

patients having had visual hallucinations of various kinds during the attacks.

In 1890 F. Peterson<sup>114</sup> published the report of a case of a paranoiac from the Vanderbilt Clinic who had visual hallucinations which consisted of seeing skeletons and various persons moving about, always on the patient's right side. If the patient directed his eyes to the right, the visions moved further toward the right. The apparitions were seen with the eyes either open or closed. Although characterized as "homonymous hemiopic hallucinations," no note is made of the state of the visual fields or of any eye examination. The man had right-sided auditory, olfactory, and gustatory hallucinations, consisting of evil odors and peculiar tastes in his food and water. He had delusions of persecution. Peterson believed that the limitation of the hallucinations to the right visual fields of both eyes "is absolute proof of their central origin, and they doubtless arise through irritation in the cortical visual area of the left occipital lobe." There is no report of the further progress of the case or of an autopsy. Although this man was insane, the homonymous hemianopia and the gustatory and olfactory hallucinations were similar to those found in cases of temporal lobe tumors and suggest the presence of a growth in that location.

In the same year Déjérine, Sollier, and Auscher<sup>39</sup> reported two cases in which hallucinations consisting of figures of people were seen, and softening of the occipital lobes was found at autopsy.

In 1890 Wollenberg<sup>168</sup> reported the case of a widow, aged sixty-one years, who, three days after an attack of vertigo, epileptiform convulsions, and loss of speech, had hallucinations in which at various times she saw strange yellow figures moving along the ceiling—dolls, dogs, large goblets, royal garments, yellow stars, a fairy ball, ants, and snakes. There was a gradual onset of bilateral choked disc, left homonymous hemianopia, conjugate deviation of the eyes to

the right, right hemihyperesthesia, and left hemiplegia. At the end of about four months the patient died in deep coma. Autopsy showed a gliosarcoma about the size of a hen's egg which occupied the right occipital lobe. The cortex in the lower part of the occipital lobe was entirely destroyed, but a considerable strip of the cortex and medullary substance was preserved inward, upward, and externally.

During the period from 1890 to 1925 Henschen<sup>67</sup> reported a large series of cases of lesions of the brain, 16 of which had visual hallucinations. The following are representative abstracts from his reports:

Case 16: A married woman, aged seventy-two years, addicted to the use of alcohol, after three apoplectic attacks which caused a bilateral hemiplegia and a left-sided hemianopia had hallucinations in which persons appeared to be trying to get into her bed. At another time she asserted she saw her daughter lying dead in a bed to the right of her. At autopsy the intracranial arteries were found to be atheromatous. Histologic examination showed an atrophy of the optic radiations in both occipital lobes, atrophy of the left optic nerve, and a partial atrophy of the chiasm. The pulvinar was cystic and the geniculate bodies contained necrotic cells.

Case 21: A woman, aged sixty-one years, had severe localized left frontal headache, convulsive seizures, and reduced vision in the left eye. Visual hallucinations consisted of flashes of light and stars and on one occasion she saw her deceased husband sitting on her bed. At autopsy a round, firm, syphilitic tumor was found in the superior gyrus of the left frontal lobe.

Case 22: A syphilitic man, aged sixty years, became bedridden after a stroke of apoplexy. The attack was followed by verbal agraphia, mind blindness, a left homonymous hemianopia, and visual hallucinations, in which the patient saw, always in the left field of vision, persons, objects

for which he reached, and his superior officers. At autopsy the arteries of the brain were found to be in a condition of atheroma. The right occipital lobe, the right pulvinar, the right thalamus, the internal geniculate body, and the right optic tract were atrophic.

Case 34: A girl, aged eighteen years, became mentally confused, and complained of amnesic aphasia, word blindness, and hallucinations in which simple gowns appeared as beautiful decorations. The patient died of tuberculous meningitis, and at autopsy the brain was found to contain many large tuberculous masses along the larger blood vessels in the thickened pia at the base around the chiasm, pons, and medulla; a large, cheesy focus was present in the left parietal lobe, and numerous large tubercles were seen in the right occipital lobe.

Case 35: A man, aged sixty-nine years, had had more than 20 strokes of apoplexy over a period of years. These attacks were almost always accompanied by temporary left hemianopia, with temporary visual hallucinations projected to the left side. At different times he imagined that he saw a fire, pigs eating oats on his bed, strangers standing near a wall, soldiers with drawn swords, a burning candle on a table, a boy with a blue suit selling blue newspapers, crowds of people, children, dogs, horses, colored people, men with black beards in blue overcoats, and many other objects. Eventually the hemianopia became constant. On March 14, 1892, the patient died in coma. At the autopsy the changes found in the brain consisted of softening and cystic degeneration of a large part of the left parietal lobe and of the left angular and the middle occipital gyri, atrophy of the right pulvinar, the right internal capsule, the right geniculate bodies, the right optic tract, the globus pallidus, and the anterior brachium.

Henschen believed that before visual hallucinations could occur it was essential that the occipital lobes be involved.

In the foregoing case (Case 35) he explained the hallucinations by the stimulation of the *occipital cortex* by a large cyst in the parietal lobe and multiple hemorrhagic foci in the right supramarginal, posterior central, and superior parietal gyri. This investigator was so imbued with the belief that the occipital cortex was the seat of all visual hallucinations that in Case 10 of his series, in which, on postmortem examination, a large glioma was found occupying the greater part of the right parietal lobe, he explained the visual hallucinations that had been present during life by assuming a stimulation of the occipital cortex by hemorrhages in the pia over the left occipital lobe.

Likewise in Case 11, in which after death a large round tumor was found occupying the right parietotemporal lobe and involving the right optic radiations, the visual hallucinations that had existed before death were attributed by Henschen to meningeal irritation of the surface of the occipital lobes.

In Case 20 the visual hallucinations were ascribed to a general intracranial pressure, although at autopsy a globular tumor was found which involved the left parietofrontal lobe and the dorsal optic radiations up to the parieto-occipital fissure.

Case 38 was that of a married woman, forty-eight years of age, who had visual hallucinations which at various times consisted of seeing black figures dancing on a wall, the driver of an approaching carriage wearing two hats, and small hillocks arising in front of her feet when walking along the road. At autopsy a large oval tumor was found which was adherent to the dura, compressing the entire temporal lobe which formed the tumor capsule. As to the hallucinations in this case, Henschen stated that it was debatable whether they constituted actual hallucinations or were illusions arising from ocular congestion.

In the greater number of Henschen's cases the lesions in

the brain were so widespread that it is not reasonable to ascribe the visual hallucinations to irritation of any one localized area. In the cases in which the lesions were in other lobes he sought for minor changes in the occipital lobes to confirm his theory that local irritation of the occipital lobes was the direct cause of the visual hallucinations. The author agrees with Horrax,<sup>72</sup> who, commenting upon Henschen's work, stated: "The author's inferences as to the causative lesions must be considered as speculative. One fact, however, was clear, namely, that in all instances there was a demonstrable damage to some part of the visual pathway between the midbrain and the calcarine cortex."

In 1891 de Schweinitz<sup>136</sup> reported the case of a man who had an attack of "morbid sleep," followed a month later by a number of general convulsions. Following these seizures he became irrational and violent, remaining so for twenty-four hours. A slight optic neuritis and a complete left lateral hemianopia were present. The patient had previously seen visions of chairs, tables, and other articles of furniture in the visual fields which afterward became hemianopic. Later an autopsy was performed and a gummatous infiltration was found at the base of the brain pressing upon the right optic tract, in association with more or less edema of the pia mater and meningitis.

In 1891 F. Peterson<sup>114</sup> reported a second case of hemianopia with hallucinations. The woman, aged forty-five years, became blind in the left half of the field of vision. One week after the occurrence of the blindness, hallucinations, consisting of children, cats, and dogs, appeared in the blind region. The children moved in circles, the cats and dogs, lined up in rows, remained stationary. The hallucinations continued—except during sleep—without variation for four weeks, when they disappeared, but the hemianopia remained. No note was made of the condition of the interior of the eyes or of the final outcome of the case.

In 1899 Uthoff<sup>153</sup> published a report of nine cases of visual hallucinations.

Case 1: A woman, aged sixty-seven years, had a bilateral, atrophic, choroidal lesion which caused an absolute central scotoma in each visual field. In the scotomas the patient from time to time saw lying on a paved courtyard grape-vine leaves which grew into a tree, beautiful flowers of all colors, the head of a lion, the portrait of a friend, a golden star on a black background.

Case 2: A woman, aged forty years, after enucleation of her left eye, complained of visual hallucinations that issued from the stump of the enucleated eye. These consisted of floating clouds and yellow and blue luminosities, which changed into flying birds, which in turn were transformed into angels and human beings.

Case 3: A paranoiac, about fifty years of age, who used alcohol to excess, claimed that he saw a policeman in front of the left eye. Ophthalmoscopic examination showed a large, atrophic, choroidal focus in the macula. In the left visual field there was a corresponding large central scotoma.

Case 4: A cabinet maker, aged forty-seven years, had a bilateral secondary optic atrophy. He complained of visual hallucinations in which he saw a large dial with numbers, but without hands, which became transformed first into two glass discs, then into a large iron grate with glowing and interlacing bars. These bars merged into a large wall of fire through which the patient saw his son sitting at a table. After about one day these phenomena were replaced by white and gray herons, swallows, and ducks slowly flying about. Vision was reduced to finger counting at about 2 meters.

Case 5: A man, at the age of forty-eight years, was totally blind from a bilateral optic atrophy due to tabes dorsalis. After blindness set in his former visual sensations of fogs or veils were changed to diffuse colored phenomena,

occasionally to seeing dogs, people mounting stairs, grocery stores, and blue and white checked draperies.

Case 6: An unmarried woman, aged seventy-two years, developed a right-sided complete hemianopia. Visual hallucinations appeared in the blind fields, and were perceived as many giants and dwarfs standing along a dazzlingly white road. The phenomena persisted for weeks, gradually faded, and finally disappeared.

Case 7: A married woman, at the age of fifty-six years, suffered a left-sided homonymous hemianopia. In the blind left field she saw small children with hats and sunshades, a shelf with vases, pots and pans, pipe bowls with painted figures, churches, laces and flowered tulle, diminutive human figures, soldiers, and animals of various kinds. The phenomena, at first immobile, now were thrown into constant motion, and they were variably red, yellow, green, blue, or white. Later the patient had an apoplectic seizure followed by hemiplegia.

Case 8: A married woman, aged seventy-three years, developed a left-sided hemianopia. The hallucinations consisted of distortion of the faces of her attendants and members of her family; the furniture looked queer and disarranged. Several years later the patient died of "cardiac paralysis."

Case 9: A man, aged sixty-five years, who was blind from bilateral detachments of the retina, on certain days perceived a dazzling white stucco wall, whereas on other days it was black as night. At times the bright periods started with a dazzling band forming in the left eye and extending rapidly until it became a sea of light, often with a particularly blinding center.

Uhthoff believed that in all his cases the hallucinations were central in origin. He was of the opinion that in order to have visual hallucinations the cortical visual centers must be partially preserved. No autopsies were reported in his series of cases.

In a paper published in 1904 Pick<sup>117</sup> supported Jolly's theory that: "A form of excitation phenomenon in the hemianopic field of vision, viz., scotoma scintillans, has its origin not in the cerebrum, especially not in the cortex, but in the primary optic tracts." Pick concurred in that observation and aimed "to prove that more complicated phenomena than elementary light sensations, as characterized by the scintillating scotoma—i. e., real hallucinations may be produced in the hemianopic field of vision by localized focal or functional affections in the optic tracts." He believed that the commonly accepted theory that visual hallucinations indicated a lesion in and limited to the occipital lobe was not correct. He described the symptoms of four cases in detail. Three of the patients had a lateral hemianopia with visual hallucinations occurring in the blind fields. The fourth case exhibited a most interesting and rare condition; i. e., a bitemporal hemianopia with visual hallucinations of persons, pictured scenes, panoramas, and mirages seen in the blind fields.

None of the cases was operated upon or came to autopsy, and there was no proof that the optic tracts alone were involved. In two of the cases the symptoms found were those common to temporal lobe tumors, and in one case the symptoms were those common to temporoparietal lobe tumors. In the light of more recent reports of neoplasms of the temporal lobe, and from the studies of the course of the optic radiations by Archambault<sup>177</sup> and by Meyer,<sup>178</sup> the author believes that the conclusion that the hallucinations of vision in Pick's first three cases were the result of pressure upon the optic radiations, rather than upon the optic tract, is justified. Their explanation by pressure upon the optic tract, however, is not impossible, as de Schweinitz' case of a gumma pressing upon the optic tract has demonstrated. Cushing,<sup>34</sup> discussing visual hallucinations associated with homonymous hemianopia, refers to one of Dr.

Pick's cases as follows: "In an earlier paper by Pick (Am. J. M. Sc., 1904, cxxvii, p. 82) there is a good example of what I would take to be a left temporal lobe tumor which he localized, however, in the angular gyrus."

Mills and Camp<sup>100</sup> in 1905 reported a case of visual hallucinations with crossed amblyopia in a woman, sixty-three years of age, who two years before had had an operation upon the left eye for glaucoma. The vision was 6/12 in the right and 6/18+ in the left eye. In September, 1904, the patient had a cerebral seizure in which the right eye became totally blind and vision in the left eye was greatly reduced. There was a loss of coordination of movements, and the patient could not stand. Two weeks later a violent delirium came on suddenly during the night and four days later visual hallucinations appeared. These consisted of visions of men with knives and pistols attacking the patient's son and husband. At times the visions took the form of flames and fires.

Autopsy: The arteries at the base of the brain were intensely sclerosed. The pregeniculates on both sides were atrophied, as was also the left optic nerve. Sections from the tissues around the calcarine fissure of each side and from the cortex of each occipital lobe showed intense congestion, with the formation of numerous fine capillaries in the second and third layers of the cortex. The pyramidal cells in their vicinity were degenerated. The pathologic changes found in the brain of this patient were so extensive that no conclusions could be drawn that would be of value in localization.

In one of the nine cases of temporosphenoidal lobe tumors reported by Kennedy<sup>86</sup> in 1911 the patient was subject to visual hallucinations. A female, aged thirty-nine years, was admitted to the hospital on June 15, 1908. Since the age of fourteen she had had occasional epileptic seizures of an ordinary character and without preceding auras. In May, 1907, while dressing, she suddenly heard a bell ringing, saw

a strange, wicked-looking woman clothed in rags, and smelled an evil odor. During 1907 and 1908 the patient had repeated attacks of a similar nature. The vision was reduced in each eye, and the visual fields were concentrically contracted. Intense papilledema was present.

At operation a subcortical tumor about the size of a tangerine was removed from the anterior part of the right temporosphenoidal lobe.

This case almost paralleled that reported by Jackson and Beevor<sup>77</sup> in 1889. Kennedy was impressed by the character of the visual hallucinations present in this case, and was led to formulate a theory that visual hallucinations consisting of pictured scenes and mirages have their origin in the temporal lobe.

In 1917 Schirmer<sup>133</sup> reported the case of a woman, aged forty-five years, who awoke one morning and found that she could not read because of the peculiar phenomenon that after she had read one line, which she could see clearly, she could not find the next one. The patient had a left-sided homonymous hemianopia with hallucinations. The character of the hallucinations is not described. After a few days all the symptoms disappeared. A diagnosis of a lesion, probably a thrombosis, in the right occipital lobe was made. In this case the symptoms were not unlike those present in the cases of migraine with homonymous hemianopia described by Jolly,<sup>79</sup> Ormond,<sup>108</sup> and other observers. The very rapid disappearance of the symptoms raises a doubt as to the presence of an organic lesion in the occipital lobe. De Schweinitz<sup>136</sup> (article of 1889) believes "such phenomena must be explained by temporary congestions in the highest visual centers, the function of which is later to be entirely destroyed by a permanent lesion."

In 1921 Cushing,<sup>34</sup> in his paper on "The Field Defects Produced by Temporal Lobe Lesions," reported that in a series of 663 verified intracranial tumors 59 patients had a

lesion located largely within, or which chiefly deformed, the temporosphenoidal lobe. Of the 59 patients, 13 had visual hallucinations. The following cases illustrate the types of hallucinatory pictures seen:

Case 1: A man, aged twenty-six years. Gliomatous cyst of the right temporal lobe, producing headache, diplopia, convulsive seizures, incomplete homonymous hemianopia, and choked discs. The visual hallucinations consisted of flashes of light or luminous objects.

Case 3: A woman, aged forty-three years. Gliomatous cyst of the right temporal lobe, producing a left upper homonymous quadrant defect in the fields, headache, exophthalmos, and a right lateral rectus paralysis. The visual hallucinations consisted of seeing colored lights and processions of queer figures marching on the ceiling.

Case 5: A solid glioma of the left temporal lobe, producing uncinate seizures, petit mal attacks, and upper right quadrantopsia. During the attacks flowers became more beautiful, odors were intensified, and objects seemed to be increased in size.

Case 6: A boy, aged eleven years. Cystic glioma of the lower right temporal lobe, accompanied by headache, vomiting, buzzing in the right ear, diplopia, choked discs, and homonymous left upper quadrantopsia. On three occasions there were visual hallucinations in the left field of vision. Once the impression was that of a boy on a wall. At another time the patient saw a man dressed in white, sitting by the fire, bending over to tie his shoe. On the third occasion he saw children sitting about a desk on the wall.

Case 7: A woman, aged thirty-three years. Cystic glioma of the right temporosphenoidal lobe. Symptoms: Petit and grand mal attacks, diplopia, choked discs, left hemiparesis, left lower quadrantopsia, and visual hallucinations. The patient repeatedly told the nurse on awakening that a woman friend of hers, whom she named, was in the room,

and that she wanted her husband called to speak to this woman. The imaginary person remained in the room all night, moving about, but did not talk. She was always on the patient's left. When the patient turned her head to follow her, the hallucination would also go farther to the left and disappear from the field of vision. While taking her history it appeared that a man with a gold helmet on his head came into the room with the examiner and sat in a chair beside him. During the history-taking the visionary man also had a paper and took notes. He did not leave the room until the examiner left. His face was not recognized and she could not describe it clearly.

Case 9: Right temporal diffuse glioma. Symptoms: Uncinate seizures, petit mal attacks, headache, nausea, choked discs, and left homonymous hemianopia. Hallucinations of vision: While walking across the room, the patient thought she saw to her left a black cat hunched up as if angry. Two days later she again saw the black cat on the left side.

Cushing was in doubt as to whether the hallucinations of vision of his cases of temporal lobe tumors were "part and parcel of the uncinate seizures," or were associated with pressure implication of the visual pathway or the geniculate body. He believed it was certain that they bore some relation to the damaged geniculocalcarine radiation. This belief was supported by the fact that the hallucination was always lateralized by the patient in the blind fields upon the side contralateral to the lesion. This investigator found hallucinations of vision less common in occipital lobe than in temporal lobe tumors. His impression was that the subjective visual phenomena in occipital lobe neoplasms were more likely to be of colors and lights than of pictured scenes.

Foster Kennedy, in discussing this paper, expressed the belief that irritation of the occipital lobes produces subjective visual phenomena of a crude, gross character, of a

colorful, spectroscopic appearance, whereas irritation of the temporosphenoidal lobes gives rise to hallucinations of persons and scenes, mirage-like in character. Kennedy advanced the hypothesis that an area of the brain like the hippocampal lobes, which in the lower vertebrates, through their acute sense of smell, perform some intellectual functions, could at the earliest period of human life carry out primitive psychic functions and serve as a storehouse of infantile memory. This hypothesis was based on the fact that in his development from embryonic to adult life each individual passed through successive stages analogous to those through which the race had passed. According to this theory, memory pictures might be implanted in a very early period of life in the temporosphenoidal lobes, and in a later period a more highly placed mechanism, perhaps in the frontal areas, might be put to the same purpose. These early memories would pass into subconsciousness and emerge only occasionally to consciousness in the presence of gross irritation of this area.

Adolf Meyer, in discussing Cushing's paper, expressed the opinion that diffuse irritation of the optic path is more likely to give constructive and pictorial hallucinations than is some more local irritation.

In 1921 H. H. Hoppe<sup>70</sup> reported the case of a man, aged ninety-one years, who at the age of sixty-one years had had a right-sided hemiplegia with aphasia from which he recovered completely in three months. For four weeks the patient had complex visual hallucinations in which he saw pictured scenes.

The vision, the visual fields, and the fundi were normal. Hoppe was of the opinion that the visual memory association was lost, as was shown by the fact that the patient was not able to interpret the meaning of pictures shown him, and that the patient's synthetic and analytic visual memory, which is a function of the visuopsychic area, was defective.

Hoppe believed that the clinical picture was produced by an irritative and possibly partly destructive arteriosclerotic lesion of the visuopsychic area, but there was no anatomic verification of that belief.

In 1922 Leroy<sup>90</sup> published a paper on lilliputian hallucinations in which he described animated, colorful, diminutive figures of a most pleasing type, which appeared to a music hall dancer following an injury to her head. The figures consisted of little men, from 4 to 12 inches tall, clothed in red, who played animated dance airs upon musical instruments. At operation a subdural effusion of blood was found. The location of the blood clot was not stated. Subsequent to the operation there were unpleasant visions of animals and wicked men who tried to assassinate the patient, with a reappearance also of the diminutive musicians.

In 1923 Horrax<sup>72</sup> reported 17 cases of hallucinations of vision from the records of Cushing's clinic. In all 17 cases the temporal lobe was involved by the neoplasm. The report included those cases of visual hallucinations published by Cushing in 1921 which serve as examples of the type, some of which have been described briefly in this paper.

Definite hallucinations of figures appeared in 12, and phenomena of less elaborate character in five cases. In six cases that came to autopsy the optic thalamus and optic radiations were involved and in none was the occipital lobe diseased. In the other 11 cases tumors or cysts were demonstrated at operation.

In 11 cases of verified occipital lobe tumors at the Cushing clinic there was no record of visual hallucinations of the type of imaginary visual images.

Of the 24 cases of brain tumor reported by Dowman and Smith<sup>40</sup> in January, 1931, five patients had had visual hallucinations as follows:

Case 6: A boy, aged six years, had visual hallucinations the character of which was not described. At operation a

cystic angiosarcoma was removed from the left parietal lobe.

Case 8: A woman, aged thirty-four years, had hallucinations of vision of a complex character, such as seeing an automobile above the treetops. At operation a large meningioma was removed from between the right frontal and temporal lobes.

Case 14: A woman, aged thirty-seven years, had seen flashes of light in the left visual field. She was found to have a left homonymous hemianopia, and at operation a large metastatic carcinoma was removed from the right occipital lobe.

The next two cases are of particular interest in that there were tumors of the cerebellar lobes with visual hallucinations.

Case 19 was that of a man, aged thirty-two years, who had had visual hallucinations which consisted of seeing flowers on his right side. At operation a large hemangioblastoma of the right cerebellar lobe was found.

Case 20: A man, aged thirty years, had visual hallucinations in which he saw objects to the right of him. At operation a large cyst was found in the left cerebellar lobe.

In January, 1931, Deery<sup>37</sup> reported the following two cases of posterior cranial fossa tumors in which the patients were subject to hallucinations of vision:

Case 1: A woman, aged twenty-seven years, on several occasions, while attending church services and looking at the priest, saw him suddenly appear to be several stories in height, after which he would shrink to normal size and then again grow extremely tall. Several times when talking to her friends the face of one of them would appear to be snow white and then change to a coal black. She had frequent visions in which she saw a man directly in front of her with the lower half of his body encased in a drain-pipe. There were other visual episodes in which there were periods of intense darkness followed by hallucinations of vivid red and

green colors. At times she believed she saw a wagon standing in a farm yard. The patient died, and the autopsy disclosed a large irregular and nodular acoustic neuroma lying in the left cerebello-pontine angle.

Case 2: A man, aged twenty-nine years, for two years had seen at intervals a large blue and at times a yellow flame which resembled an electric discharge between two electrodes. The vision was always seen at the left, and occurred at any time during the day or night and with the eyes either open or closed. At times he saw a large, dark-colored inverted bowl, somewhat above and straight in front of him.

At operation a large midline extra-arachnoid cerebellar dermoid cyst was removed. Following the operation the patient suffered no further visual hallucinations.

Deery comments upon the possible mechanisms involved in the production of visual hallucinations in posterior fossa tumors as follows: "It is conceivable that a bulging tentorium, pushing upward, might constitute a local irritation of the occipital lobes. Explanations based upon increased intracranial pressure are difficult to accept, unless we postulate an irritation of the higher mental centers. Interference with the blood supply to some part of the optic pathway might conceivably be held a factor. The posterior cerebral artery so situated that it might suffer from pressure effects lends itself to speculation. By its median and posterior lateral ganglionic branches this vessel contributes blood to a large part of the optic pathway, from the thalamus and temporal lobe to the occipital pole. However, it is apparent that any single factor common to subtentorial growths in general is not the cause. It is not inconceivable that some one of these factors or a combination of them acting in the presence of an unusually sensitive visual mechanism may be the true explanation."

Dr. C. Burns Craig has called the author's attention to a unique case seen on his service at the Neurological Institute,

New York, and reported by Sanger Brown and Thomas K. Davis.<sup>23</sup> This was a case of multiple sclerosis with visual hallucinations. As it is the only case of its kind found in the literature, the author considers it to be of sufficient interest to report somewhat fully.

Miss S., at the age of twenty-eight years, was admitted to the Neurological Institute on November 2, 1921. Her history showed that in 1916 she had begun to have attacks of weakness, trembling, staggering, and difficulty in walking. For some time before admission she had been subject to auditory and visual hallucinations. On occasion there was imperious micturition with incontinence of the bowels.

Examination revealed a bilateral Babinski reflex, nystagmus in the lateral and upward fields of vision, bilateral central scotoma, bilateral temporal pallor of the optic discs, and unequal pupils.

The scotomas had disappeared by April 19, 1922, on which date vision was: O.D. = 6/18; O.S. = 6/24.

The hallucinations were extremely variable. At times the patient saw flames, sparks, and smoke arising from the rug; at other times she saw plants, or the house would appear to be on fire. One day, while lying on the couch, she saw a cat which leaped from the floor onto her feet. On another occasion she saw two strange persons approaching the front door. She saw a neighbor hosing the porch, green bugs crawling on the window-panes, a mouse running about the room. Other persons who were present saw none of these things, and the patient realized that these phenomena were not genuine.

In a recent communication, about sixteen years after the onset of the malady, the patient stated that she was still subject to hallucinations in which she sees persons and smoke, and that at times news print appears to be red.

## CASE REPORTS BY THE AUTHOR

The following cases were admitted to the various services of the Neurological Institute and were studied by the author through the courtesy of Dr. Elsberg, Chief of the Surgical Service of that institution:

CASE 1.—W. O'R., male, aged forty-two years, was admitted June 3, 1931.

*History:* Two months ago the patient began to have severe headache in the right occipital region, with pain radiating to the right frontal area. During the past year he had lost 30 pounds in weight. He tired easily, his gait was unsteady, and for two months he had had difficulty in maintaining his balance. Two weeks previously the patient had had visual phenomena in which he saw grape-vine effects in the lateral fields of vision. Later he saw a man dressed in black mediaeval armor. On the same day he saw geraniums and flowers with long stems. At another time he saw flashes of circular light.

Neurologic examination showed positive Oppenheim and Gordon reflexes, and slight deviation of the jaw and uvula to the left.

*X-ray Examination:* The pineal gland was calcified and displaced backward and downward. Ventriculogram showed air in the left ventricles only. Vision O.D. = 6/9; O.S. = 6/5. There was bilateral papilledema of from 3 to 4 D. Except that the blind-spots were enlarged, the visual fields were normal.

*Diagnosis:* Tumor in the posterior part of the right frontal lobe.

*Operations:* On June 13, 1931, a right osteoplastic flap was made in the right frontal region, and at a secondary operation on July 21, 1931, Dr. Stookey did a subtotal resection of the right frontal lobe with a subtotal removal of a right frontal glioma. The tumor was found to extend to the opposite side of the brain.

On December 17, 1931, the patient was at home. The right frontal area was bulging, he was depressed, he had some loss of memory of names, and he had a bilateral secondary optic atrophy.

*Comment:* This patient had a large tumor which was not confined to the posterior portion of the right frontal lobe, but extended to an unknown extent to the left side of the brain. The pressure upon the visual pathways was not sufficient to produce defects in the visual fields, but the hallucinatory phenomena in both lateral fields of vision indicate some pressure upon, with irritation of, the

chiasm. The enlarged blind-spots and the optic atrophy were secondary to the edema of the nerve heads.

CASE 2.—C. T., male, aged sixty-four years, was admitted September 5, 1931.

*History:* The onset of the disturbance took place about the middle of May, 1931, when the patient became confused, disoriented, and began to have hallucinations of seeing unknown men and women in his room when none was present. Everywhere he looked he saw his wife. He knew that the images were not real. Although formerly he was optimistic, he now became pessimistic.

Upon examination he was found to have a left hemiparesis, a left Babinski reflex, a left cortical facial weakness, and he past-pointed to the right. He had sleep reversal. The pineal gland was displaced to the left. He had a left homonymous hemianopia and blurred disc margins.

*Diagnosis:* Right temporofrontal tumor.

*Operations:* On October 21, 1931, a right subtemporal decompression was done. On November 4, 1931, Dr. Masson did a second-stage operation, turning down a low right frontotemporal osteoplastic flap. A meningioma was found lying under the right temporal lobe. Above the meningioma a yellowish tissue was seen and removed. This was found to be an astrocytoma. The patient's condition was such that the meningioma was left to be removed at a third-stage operation. He died of pneumonia on March 29, 1932.

*Comment:* This was a case of a tumor pressing upon the optic radiations in the temporal lobe, producing homonymous hemianopia with visual hallucinations of the type stressed by Cushing and by Horrax.

CASE 3.—H. R., male, aged thirty years, was admitted January 23, 1931.

*History:* On July 4, 1906, the patient was shot in the back of the head. In 1918 he developed attacks of illusions and headache which had continued to the date of admission. During the attacks he did not lose consciousness, but the head turned to the left and the body became rigid. The attacks were preceded by an aura which consisted of a chain of lights which appeared on the left side and which he turned his head to follow as the lights moved to the left. The lights flickered, gradually became stronger and more brilliant, moved faster and faster to the left, and then

faded. Although the patient believed that he did not lose consciousness, his mother declared that he did become unconscious during the attacks. He did not froth at the mouth, bite his tongue, or become incontinent.

Examination revealed a left Babinski reflex, increased deep and decreased superficial left reflexes, and a left homonymous hemianopia. There were loss of dexterity of movements and disturbance of associated movements of the left side. X-ray examination showed a fracture of the skull in the right inferior occipital region and a foreign body in the right occipital lobe.

*Operation:* On March 20, 1931, Dr. Stookey made a right occipital bone flap and removed a bullet and a surrounding scar from a point immediately above the tentorium, about one-third of the distance from the midline.

When last seen, on January 21, 1932, the patient had remained free from all symptoms, except for a left homonymous hemianopia which persisted.

CASE 4.—J. A., a male, aged fifty years, was admitted June 12, 1930.

*History:* One day in November, 1928, he had had convulsions that continued all day, and from that day the seizures had returned at intervals, becoming more frequent recently. For a month before admission he had had pains in the head, sleeplessness, dizziness, diplopia, nausea, loss of weight, failing vision, flashes of light, and difficulty in walking.

Examination showed a staggering gait, spasticity of the right side, exaggerated deep reflexes, more exaggerated on the right than on the left side, positive Romberg, Babinski, and confirmatories with trunk-thigh sign on the left. There were dysarthria, a complete right homonymous hemianopia, a bilateral papilledema of from 4 to 5 D. Skilled movements were absent on the right side. X-ray examination showed a posterior displacement of the pineal body.

Headaches were frequent, severe, and often were attended by visual phenomena. There would be darkness, which would later begin to clear up, and as the vision gradually improved bright flashes of colored light would appear, usually starting temporally from both sides. At times there were flashes of bright light. At others he saw before him the head of an old man, a cow, and dead objects.

*Operations:* On June 17, 1930, Dr. Masson performed a left

temporal osteoplastic section and found an inoperable tumor, a piece of which was removed for histologic examination. On August 21, 1930, Dr. Klenke did a left occipital decompression.

The patient died on February 28, 1931, and autopsy revealed a spongioblastoma multiforme of the left parieto-occipital lobe.

CASE 5.—A. C., a youth, aged eighteen years, was admitted August 4, 1930.

*History:* The onset of the disturbance occurred on May 15, 1930, with occipital pain, vomiting, and diplopia.

Upon examination it was found that the patient had dysmetria, asynergia, ataxic speech and gait, and a positive Romberg. Corrected vision was reduced to 6/60 in each eye. He had a right sixth nerve paralysis and a bilateral optic atrophy. The visual fields taken with a large test object showed a bitemporal hemianopia. His hallucinations consisted of seeing a river in front of his bed and of seeing three men with their heads covered.

*Operations:* On August 21, 1930, Dr. Klenke performed a right suboccipital craniotomy and removed 40 c.c. of fluid from the right cerebellar lobe. At a second-stage operation on October 21, 1930, Dr. Stookey removed 10 c.c. of fluid and an astrocytoma, 2 by 3 cm. in size, from the right cerebellar lobe. The patient recovered, and on January 14, 1932, his vision consisted of hand movements.

*Comment:* It would seem that the firm, strong tentorium would prevent pressure upon the occipital lobes and the visual centers by tumors expanding in the posterior fossa. However, the two cases reported by Dowman and Smith, and the two cases reported by Deery, of visual hallucinations occurring in posterior fossa tumors, demonstrate that such tumors may irritate the visual centers through the tentorium. The question arises whether the bitemporal hemianopia in Case 5, which began as a small peripheral lateral defect and gradually extended until it left only a small nasal field, was produced by pressure upon the inferior surface of the occipital lobes. In Case 3 the bullet had entered low and remained near the tentorium in the occipital lobe, yet the patient had a homonymous hemianopia and not a quadrant

defect. Of course, these changes could be produced by injury to the association tracts. It is interesting to reflect, however, upon the question as to whether or not the lateral halves of the retina are supplied by fibers originating in the lower parts of the occipital lobes.

Deery believed that it was conceivable that an upward bulging tentorium might irritate the occipital lobes, or that pressure effects upon the posterior cerebral artery might be a factor in producing hallucinations by interfering with the blood supply of the visual pathway. He was of the opinion that the true explanation of visual hallucinations in posterior fossa tumors might lie in an unusually sensitive visual mechanism acting in conjunction with one of the foregoing factors or in a combination of them.

#### THEORIES CONCERNING LOCATION AND FUNCTION OF THE VISUAL CENTERS

To have a clear understanding of the method by which visual hallucinations may be brought about it is necessary to have in mind the location and function of the higher visual centers.

The experiments of Ferrier,<sup>176</sup> Munk,<sup>103</sup> Schäfer,<sup>131</sup> and others on animals have demonstrated that the higher visual centers are located in the occipital lobes and the angular gyrus of the parietal lobe. Ferrier believed that the cortex of the angular gyrus was the dominant area of the higher visual center, whereas Schäfer, from his experiments, concluded that the part played by the cortex of the angular gyrus was small as compared to that of the occipital lobe. In this respect he agreed with Munk.

Henschen<sup>67</sup> has expressed the following views in scattered comments in his reports: (1) The visual center is located on the medial surface of the occipital lobe. (2) Presumably the centers of visual perception and memories are separately located: in the right occipital lobe for left and in the left

occipital lobe for right visual perceptions and memories. (3) The center of visual memories is apparently not identical with the center of visual perception, and up to a certain degree both function independently of each other. (4) Functional mind-blindness is presumably localized in the occipital lobe. (5) After destruction of the visual center, actual visual memories can arise, probably in the same cerebral hemisphere.

Campbell<sup>24</sup> is of the opinion that recent researches afford proof that the convolutions that form the walls of the calcarine fissure and include the line of Gennari are the chief end-station of the optic radiations, constituting, therefore, the cortical center for the primary reception of visual sensations—the visuosensory area. Immediately adjoining and almost surrounding the visuosensory area is a region with a distinctive histologic structure which Campbell believes is the visuopsychic area, the function of which is the final elaboration and interpretation of visual impulses.

Numerous case reports of lesions involving the angular gyrus have shown that injury to the cortex of this gyrus produces an inability to comprehend written language, or alexia. As early as 1888 Macewen<sup>179</sup> reported the case of a man who had received an injury to the head a year previously. Immediately following the accident he had suffered from psychic blindness, deep melancholy, and homicidal tendencies. He could see, but what he saw conveyed no impression to his mind. He could recognize objects by the sounds that they emitted or by the sense of touch but not by sight. Printed words were unknown symbols to him and conveyed no meaning. At operation the angular gyrus was exposed, and it was found that a portion of the inner table of the skull had been detached and was pressing upon the posterior portion of the supramarginal convolution, while a corner of the fragment lay embedded in the anterior portion of the angular gyrus. Removal of the pressure relieved the patient of his symptoms.

Bennett and Gould, Monakow, Redlich, and Verrey have reported cases of alexia, the causative lesion being confined to the left angular gyrus and the second occipital convolution.

Ferrier<sup>176</sup> believed that the higher visual centers of each side supplied fibers to each half of the retina, and that from the central field of vision impulses from each half of the macular region reached each higher visual center. Gowers<sup>61</sup> confirmed this belief and was of the opinion that the macula of each eye had bilateral representation in the higher visual centers. This theory is supported by considerable experimental and clinical data. Mills and Camp<sup>100</sup> and other observers have reported cases of crossed amblyopia which seem to support Gowers' view.

The fact has been established that in each occipital lobe there is a center for half vision—in the right lobe for the reception of stimuli from the left half of the visual field, in the left lobe for the reception of stimuli from the right half of the visual field. It is a generally accepted fact that the higher visual centers have visuosensory and visuopsychic stations. The visuosensory stations receive visual stimuli and have the function of perception. The perceptive impressions are relayed over association fibers to the visuopsychic stations, where they are stored as memory pictures. Visuopsychic impressions that are new are compared with previously received impressions, they activate previously stored memory pictures, and reach a proper niche for storage and later use.

H. H. Hoppe<sup>70</sup> believes that these stored memory pictures can be recalled to consciousness by will, by stimuli coming from the other cortical areas through the association tracts or through the visual organs. He is of the opinion that the flow of stimuli is always from the visuosensory to the visuopsychic area, and that stimuli from the visuopsychic and other cortical areas cannot stimulate the visuosensory areas under normal conditions, but that under abnormal conditions

memory pictures stored in the visuopsychic area may stimulate the visuosensory area and be projected into space as hallucinations.

McCorn<sup>95</sup> believes that a hallucination is never an entirely new creation, but that it is a reproduction of memory pictures. Where the hallucination seems to be strange and enigmatical to the patient, McCorn is of the opinion that it is a new combination of the component memory pictures.

Tuke<sup>151</sup> believes that in order to have visual hallucinations it is not necessary for the peripheral sense organs to be able to function, but that it is essential that there be sensory images to recall. He quotes Mr. Buckle, B.A., Superintendent of the Wilberforce School for the Blind, of York, England, who investigated the subject for him, as finding that those pupils who had no remembrance of having seen, never had had dreams of seeing objects or experienced visual hallucinations.

How are visual hallucinations produced and in what area of the brain are they elaborated?

#### THEORIES

Four theories have been advanced to explain the production of the visual phenomena in question.

The *first theory* is that of Jackson,<sup>78</sup> who in his Croonian Lecture suggested the hypothesis that there is a center for visual ideation made up of the anatomic bases of visual images only; that in this center images of innumerable objects of different shapes and colors are stored; and that the center contains countless nervous arrangements each of which represents different retinal impressions and different ocular movements. These are, anatomically, sensorimotor nervous arrangements; physiologically, they are reflex actions. During slight activities of this center, unprovoked by peripheral stimuli, faint visual ideas develop; during strong activities, provoked by peripheral agencies, vivid visual ideas

are elaborated. Under abnormal conditions, if some of the cells of the nervous arrangements of these centers as the result of any pathologic process become highly unstable, to so marked a degree as occurs in epilepsy, the consequence will be that many nervous arrangements will occasionally discharge suddenly, simultaneously, and excessively. According to Jackson, visual hallucinations, therefore, are sensory discharges analogous to the motor discharges that occur in epilepsy. He believed that stimuli coming from a distant part over the association tracts could produce hallucinatory phenomena, and that it was not essential that the disease should involve a part of the cortical center concerned.

The *second theory* is that of Henschen,<sup>67</sup> who, after a careful clinical and an exhaustive pathologic study of a comparatively large number of cases, concluded that: (1) Unilateral visual hallucinations with simultaneous hemianopia suggest localization in or near the cortex of the occipital lobe. (2) Color hallucinations originate on the lateral aspect of the occipital lobe. (3) Visual hallucinations are an occipital lobe cortical symptom.

The *third theory* is that of Jolly and of Pick. Jolly<sup>79</sup> advanced the theory that scintillations in the hemianopic fields, in cases of scotoma scintillans, had their origin in the primary optic tracts and not in the cortex of the cerebrum.

Pick<sup>112</sup> confirmed Jolly's theory, and proved to his own satisfaction that "more complicated phenomena than elementary light sensations, i. e., real hallucinations, may be produced in the hemianopic field of vision by localized focal or functional affections in the optic tracts, geniculate bodies, and optic thalamus." He was of the opinion that the commonly accepted belief of that time, that such hallucinations were of value for the localization of lesions in the occipital lobe, was without foundation. As none of the cases

of Jolly and of Pick came to autopsy, no anatomic data are cited to support this theory.

The *fourth theory* is that of Kennedy,<sup>86</sup> who believes that irritation of the occipital lobes produces subjective phenomena, but of an extremely crude, gross character—such as colorful, spectroscopic appearances—whereas irritation of the temporal lobes produces complicated hallucinations of persons, pictured scenes, panoramas, and mirages, which are almost always constant for each patient. In reference to the pictured scenes and mirages of temporal lobe tumors, Kennedy's theory is: "Every individual, in his ascent from embryonic to adult life, passes through the stages through which the race has passed. The lower animals make their chief intellectual contact with their environment by means of the hippocampal lobes, which in man are relatively small and unimportant. It may well be that these areas subserve in man early intellectual functions which in later life are carried on by some higher mechanism. If this theory is true, then one may regard these apparitions as involuntary resuscitations of early, perhaps infantile, memory patterns."

Horrax,<sup>72</sup> reflecting upon the evidence furnished in his series of temporal lobe tumors, came to the conclusion that in tumors of that area the visual hallucinations were the result of a direct irritation or effect in the temporal lobe itself. This conclusion was based upon the fact that the visual pictures are so often associated with the gustatory and olfactory seizures that characterize the uncinate syndrome in the temporal lobe tumors. This investigator's conclusions, therefore, are in accord with Kennedy's theory.

Cushing<sup>34</sup> has expressed himself as being in doubt as to whether the projection pictures in temporal lobe tumors are related in any way to the olfactory and gustatory discharges of the typical uncinate seizure or whether they are merely associated with some pressure implication of the visual pathways or geniculate body.

## SUMMARY

A consideration of the foregoing data shows that an irritative lesion in any part of the visual pathway peripheral to the visuopsychic area may produce visual hallucinations. Although this may be true, authentic reports of proved cases of hallucinations following irritation of the optic tract, chiasm, optic nerve, and retina are practically confined to single cases. In Case 1 of Uhthoff's series there was a bilateral, central, old, atrophic, choroidal lesion, accompanied by hallucinations of vines and beautifully colored flowers in the scotomatous areas of the visual fields. Uhthoff's Cases 3 and 9 were of a similar type. The patient spoken of in Case 2 of Uhthoff's series saw colored luminosities, flying birds, angels, and human forms issuing from the stump of an enucleated eye. Uhthoff's Cases 4 and 5 had an optic atrophy with hallucinations. Of course, there is the possibility, in his cases, of there being a lesion of the visual pathways posterior to the retina and optic nerve, as there was no anatomic confirmation of the diagnosis in any of them. Esquirol's case of calcified tumor with hallucinations is a case in point of chiasmal stimulation, and de Schweinitz' case of gumma compressing the optic tract is a conclusive example of hallucinations resulting from irritation of that structure. Apart from such isolated cases it would appear, therefore, that visual hallucinations occurring in organic lesions of the brain indicate, as a rule, an implication of either a temporal or an occipital lobe. In those rarer cases of tumors of the posterior fossa with hallucinations the explanatory theory that appears to be most probable is that the occipital lobes are implicated secondarily by pressure from below.

Does the character of the hallucinations indicate which of the lobes is involved?

Kennedy<sup>86</sup> believes that visual phenomena of a crude, gross character, such as flashes of light and colorful spectro-

scopic appearances, are associated with an irritation of the occipital lobes; whereas complex phenomena, such as objects, pictured scenes, and panoramas, are associated with irritation of the temporal lobes.

In regard to temporal lobe tumors the views of Horrax<sup>72</sup> are in accord with those of Kennedy. In support of his views Horrax reports that none of the 11 patients with verified occipital lobe tumors seen in Cushing's clinic had imaginary visual images. He does not state, however, whether or not any of those patients had hallucinations of any sort. Cushing, in discussing Horrax's paper, cited the case of a patient with an occipital lobe glioma then under his care who had a homonymous hemianopia and had been having crude hallucinations, such as seeing a crescent of light. It is quite possible that cases of occipital lobe tumors have not been so thoroughly studied and fully reported as those of temporal lobe tumors, and that definite conclusions should not be drawn until such studies have been made.

Kinnier Wilson associates the crude type of visual hallucinations with lesions in the receptive zones, and the more elaborate and highly organized type with lesions which have their origin in the cortical association areas.

Cushing<sup>34</sup> is of the opinion that in occipital lobe tumors visual hallucinations are more likely to be of colors and lights than of pictured scenes. Adolf Meyer, in discussing Cushing's cases of temporal lobe tumor, expressed the belief that "the more diffused irritation of the optic path is more likely to give constructive and pictorial hallucinations than something irritating more local." H. H. Hoppe<sup>70</sup> believes that irritative lesions of the calcarine area may cause simple or elementary hallucinations, such as flashes of light or color.

In connection with this question it is instructive to note that in Craig's<sup>31</sup> case the patient had an occipital lobe cyst and for years was subject to episodes during which he saw persons, scenes, and panoramas. Wollenberg's<sup>168</sup> patient

with an occipital lobe glioma saw objects and a fairy ball. In Seguin's<sup>139</sup> case of embolism of the occipital artery the patient saw a chicken and a chair. On the other hand, in Cushing's series of temporal lobe tumors, the patient in Case 1 saw luminous flashes and in Case 3 the patient saw colored lights and processions of queer figures. In Horrax's Case 7, a diffuse glioma of the temporal lobe which involved the basal ganglia but not the occipital lobe, the patient saw red lights to her right, a steady glow of light over the right side, in addition to little yellow people, a red colt, and other objects. In Henschen's Case 20, a parietofrontal lobe tumor, the patient saw flashes of light and persons walking around holding lighted lamps. In Case 21, a frontal lobe tumor, the patient saw flashes of light, stars, and her deceased husband sitting on her bed.

It is evident that there are cases in which the lesions are limited to the occipital lobe and in these the hallucinations consist of scenes and objects; also that there are cases in which the occipital lobes are not involved and crude hallucinations, such as flashes of light, occur. However, in the cases of tumors involving the temporal lobes reviewed in this study, the hallucinations were more often of a complex type, but some were of a mixed character, consisting of both crude and complex phenomena, and in Case 1 of Cushing's series only crude hallucinations were reported.

As to the lateralizing value of visual hallucinations, a careful study of reported cases reveals that there is none, except that when the hallucinations are projected in a blind homonymous field it is a confirmatory sign that the lesion is located in the contralateral hemisphere.

#### CONCLUSIONS

1. Visual hallucinations are elaborated in the higher visual centers in the occipital cortex.
2. The production of visual hallucinations presupposes a partially or wholly intact visuopsychic or visuosensory area.

3. An irritation of any part of the visual pathway may, under certain pathologic conditions, stimulate the higher visual centers to an elaboration of visual hallucinations.

4. Hughlings Jackson's theory of sudden, simultaneous, and excessive sensory discharges from unstable cells, analogous to the motor discharges that occur in epilepsy, offers the most logical and satisfactory explanation of visual hallucinations.

5. Crude and complex hallucinations of vision are elaborated by different mechanisms, crude hallucinations being elaborated in the visuosensory area and complex illusions in the visuopsychic area.

6. Crude visual hallucinations, such as flashes of light and spectroscopic appearances, are excessive sensory discharges elaborated in and projected from unstable cells in a special zone of the visuosensory area, the function of which is the reception and projection of light and color.

7. Complex visual hallucinations, i. e., of objects and scenes, are elaborated in the visuopsychic area and are projections of previously stored memory pictures; discharges from unstable cells in the ideation center, according to Jackson.

8. Visual hallucinations of a complex type, or of a combined complex and crude character, point strongly to an implication of the visual pathway by a lesion in the temporal lobe.

9. Crude visual hallucinations suggest an implication of the visual conduction tracts or higher visual centers in the occipital lobe. The small number of cases of lesions limited to the occipital lobe with visual hallucinations reported precludes definite conclusions as to the type of hallucinations that may be expected in lesions of that lobe. In this connection a more extensive study should be made of cases in which the occipital lobes are involved.

10. The irritation necessary for the production of visual

hallucinations may be the result of pressure upon, or invasion of, the visual pathway by neoplasms, or of changes in the pathway caused by a disturbance of the circulatory system, such as arteriosclerosis and thrombosis.

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### VISIBLE RETINAL EMBOLISM\*

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#### INTRODUCTION

As a rule, the ophthalmoscopic picture of a stoppage in the arterial retinal circulation does not furnish conclusive information regarding the nature of the obstruction. The problem of local changes, such as endarteritis, thrombosis, and angiospasm, versus true embolism, is, after all, undecided in most instances. Of particular interest, therefore, are those cases in which an ophthalmoscopic examination reveals the presence of a refractile body in the occluded artery.

This paper aims to present a discussion of embolism, with some original, experimental, and clinical data confirming the embolic origin of ophthalmoscopically visible obstructing bodies, and to review the literature on retinal embolism.†

\* Candidate's thesis for membership accepted by the Committee on Theses.

† I wish here to extend my thanks and appreciation to Dr. Ernest M. Hall, Professor of Pathology, University of Southern California, and his Assistant, Mr. Emerson Zapata, for the sections and photographs; to Dr. Charles H. Thienes, Professor of Physiology, University of Southern California, and his Assistant, Mr. L. D. Mill, for their assistance with the experimental animals; to Miss M. H. van Raalt, for her sketches; and to Dr. M. N. Beigelman, for his invaluable cooperation and assistance.